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# ON THE PERSEVERATIVE TENDENCY<sup>1</sup>

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## I. INTRODUCTORY

The spontaneous appearance of formations in consciousness, that is to say, their appearance without peripheral stimulation or associative connection, is a familiar phenomenon in the psychology of common sense, and a fundamental concept in the metaphysical psychology of Herbart. In the terms *perseveration* and *perseverative tendency* the concept has found continued and increasingly extended use in experimental psychology, since the introduction of these terms in the investigation of memory by Müller and Pilzecker (1900). In the last twenty volumes of the *Zeitschrift für Psychologie* the article on Memory which does not involve one or both of these terms is the exception rather than the rule, and much use is made of them also in the treatment of memory in other journals and in text-books. Not in the field of memory alone, however, but also in such different fields as those of feeling, rhythm, association, action and thought, do we find the appeal to the freely rising or to the persisting mental formation, and at least one writer has based a theory of introspection upon the perseverative tendency.

When an attempt is made to bring together the knowledge of perseveration which has been gained in such investigations, however, great systematic difficulty arises. As the expression "freely rising or persisting mental formations" briefly indicates, and as we shall try to show in greater detail in the historical section which follows, no single meaning has attached to the terms. They have, on the contrary, been most

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<sup>1</sup> From the Psychological Laboratory, Cornell University.

frequently used without apology and with a great variety of implications. Where criticisms have been offered, there have resulted numerous different definitions, or in some cases there has come an outright denial of the admissibility of the concepts.

While the associative tendency and even the more recently supposed determining tendency have been made the objects of special investigation, and while methods have been developed for establishing their conditions and measuring their strength, we have as yet no direct investigation of the perseverative tendency. For the most part, rather, the perseverative tendency has been invoked to explain results incidentally obtained in attacks on other problems, especially where such results seemed difficult to explain in the better recognized ways. It is in view of this disagreement as to its significance and status that we have undertaken an historical review and direct experimental investigation of the perseverative tendency.

## II. HISTORICAL<sup>2</sup>

The term perseveration seems to have been first used by the psychiatrist Neisser<sup>3</sup> to indicate the fact of abnormally persistent repetition or continuation of an activity, after the activity had been once begun or recently completed, such as is evidenced in the frequent speaking or writing of a given word or words in unsuitable places. For Neisser the term is descriptive, the name of a symptom to be recognized in the clinic. Later psychiatrists do not limit the term to this use, however. Not merely the externally evident reactions, but "perceptual and purely internal" reactions, ways of apprehending and perceiving things or situations, soon come also to be classified as perseverations. Perseveration takes on an explanatory aspect as well. For some it indicates that "inner-ner-uation processes which from some cause do not attain their goal or express themselves in one way, do so in another"; for

<sup>2</sup> A review of the psychiatric literature of perseveration is given by K. Heilbronner, Ueber Haftenbleiden und Stereotypie. *Monatsch. f. Psychiatrie u. Neurologie*, 18, 1905. Erg.-Hft., 293 ff. We are indebted to this review chiefly for the details upon which the generalizations of the first paragraph of our historical discussion are based. On the psychological side are reviews of the literature on memory for certain years by H. J. Watt. *Arch. f. d. ges. Psych.*, 7, 1906, Literaturber., 16 ff.; *ibid.*, 9, 1907, Literaturber., 22 ff., and a critical review by C. Jesinghaus, Zur psychologischen Theorie des Gedächtnisses, *Psychol. Stud.*, 7, 1911, 365 ff.

<sup>3</sup> 65 Sitzung des Vereins deutscher Irrenärzte, *Zeitsch. f. Psychiatrie*, 51, 1894, 1016.

others it means "psychical after-images," or "weakness and slowness of association," and so on. The further uses of the term in psychiatry need hardly concern us. It is enough to point out here that psychiatry offers no single standard content for the concept.

The term perseveration was not common in psychology until after 1900 when, as we have previously indicated, it was introduced by Müller and Pilzecker<sup>4</sup> in connection with the perseverative tendency. The latter term is defined by these authors as follows: "After once having entered consciousness, every idea possesses a perseverative tendency, that is, a tendency to rise freely into consciousness. The tendency generally dies rapidly away. The more intensely attention was directed upon the idea, the stronger is the tendency, and it increases if the given idea or series of ideas is very soon repeated. With cumulative repetition it may easily happen that, at times when the other factors which are besieging consciousness are not of especial strength and persistence (*Nachhaltigkeit*), the given idea or series of ideas will come to consciousness solely in consequence of their perseverative tendency." As proofs of the necessity of assuming the presence of a perseverative tendency, they give a list of observations and experimental results. (1) After one has been busy for several hours in attentive observation of a phenomenon, such for instance as the movements of a pointer over a scale, the phenomenon may suddenly present itself again, in image, with the distinctness of sensory experience, especially at times when attention is not demanded in other directions (Fechner's phenomena of sensory memory).<sup>5</sup> (2) Impressive experiences sometimes reappear in the form of hallucinations, at least at times when attention is not demanded strongly in other directions.<sup>6</sup> (3) A long continued motor activity sets up in the lower centers a tendency automatically to continue or to repeat the activity. After a strong disposition of this sort has been established, the center affected may "reel off" the activity for a certain length of time, without the necessity of further incitement (*motorische Einstellung*).<sup>7</sup> (4) Cases of perseveration, in the sense of the psychiatrists, as described above. (5) Quite against our will, ideas and thoughts in

<sup>4</sup> G. E. Müller u. A. Pilzecker, Experimentelle Beiträge zur Lehre vom Gedächtniss. *Zeitsch. f. Psychol.*, Ergbd. 1, 1900, 58 ff.

<sup>5</sup> G. T. Fechner, *Elemente der Psychophysik*, II, 1860, 498 ff.

<sup>6</sup> Fechner, *op. cit.*, 513.

<sup>7</sup> G. E. Müller u. F. Schumann, *Arch. f. d. ges. Physiol.*, 45, 1889, 37 ff. Cf. L. Steffens: *Zeitsch. f. Psychol.*, 23, 1900, 242 ff.

which we have been deeply interested for some time—melodies, chess games, and the like—may keep coming back into our minds. (6) We often make mistakes in reading, hearing, speaking or writing words, where words had in mind previous to the mistakes seem, by their continuance (*Nachklingen*), responsible for the disturbance. (7) In experiments on memory, ideas given as reactions in the first part of a series may recur during the latter part of the series without the volition of the observer, and without any evidence of special reproductive tendencies. (8) In spite of instructions not to think of the series, many observers cannot prevent certain syllables of a series which they have learned from coming to mind in the interval between the learning and the test. (9) In experiments by the method of right associates, not only may a syllable which has caught the observer's attention be given once or oftener as a response in the test of the series of which it was a part, but it may also recur as a response on a number of later days (*habituelle Aushülfesilben*). In cases where the correct associate is partially identical with such a syllable, the chances of this sort of incorrect response are increased. (10) Incorrect responses, in which the syllable spoken is a syllable from the series, but is given in the wrong place, are much more frequent in tests which follow shortly after learning than in tests which follow at longer intervals, even though the number of correct responses in the two cases is approximately the same. (11) Series tested after a short interval give shorter reaction-times than series tested after longer intervals, even though the number of correct replies is approximately equal in the two cases; and mere rereading of recently read material may be accomplished faster than rereading of older material. (12) Mental activity during a period shortly after learning not only disturbs the associative connections (retroactive inhibition), but also brings it about that the syllables are less likely to rise freely into consciousness. (13) Observers differ greatly in respect to the degree in which the above mentioned symptoms of perseverative tendency appear.

It has often been pointed out that the definition of perseverative tendency given above is not altogether unambiguous.<sup>8</sup> After its entrance (*nach ihrem Auftreten*) into consciousness, and while it is still in consciousness, an idea cannot well be said to have a tendency to rise freely *into* consciousness, but only

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<sup>8</sup> W. Wundt: *Grundzüge d. psychol. Psychol.*, III, 1911, 572. Jesinghaus, *op. cit.*, 365. W. Poppelreuter, Ueber die Ordnung des Vorstellungsverlaufes, *Arch. f. d. ges. Psychol.*, 25, 1912, 293.

to have a tendency to continue in consciousness, or to run a temporal course. Only after a formation has disappeared from consciousness is it possible to speak of its tendency to rise freely. It is difficult to say whether Müller and Pilzecker mean that the tendency explains merely the free arousal of the idea, or both this and its continuation. The analogous motor disposition brings about a repetition *or* continuation of the activity; the lower center "reels off" the activity. The syllables in the interval between learning and test may be a continuation of the series as well as a recurrence.<sup>9</sup> It may be the continuation of the series which is damaged by immediately subsequent mental work. The previous word seems to linger (*nachklingen*) in the cases where we make mistakes in speaking; and so on.

Whether or not these authors mean the perseverative tendency to explain both continuance and free recurrence, however, it is certain that others who use the term later do so understand it. Out of the many cases in which both meanings appear in the work of a single author, we choose two in which the twofold use is expressly stated. Ach<sup>10</sup> says: "The tendency of a psychical experience to rise freely into consciousness *or* to remain (*verharren*) in consciousness as an after-effect has already been established experimentally by Müller and Pilzecker, and called perseverative tendency"; and Ach refers to the memory after-image. Wertheimer<sup>11</sup>

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<sup>9</sup> Müller would probably deny the possibility of such a continuation. In his review of Ebert and Meumann's work on practice in memory (*Zeitsch. f. Psychol.*, 39, 1905, 124) we find: "It is evident at once that in immediate retention it is not a matter of after-images. The after-images of a series of auditory or visual perceptions of syllables or the like would give a simultaneous mixture of sounds or colors, and not a successive appearance of distinct single ideas of syllables, visual signs, and the like." Meumann believes, however, that in immediate recall "reproduction takes place on the basis of an immediate after-effect of the impressions and before these impressions have yet faded out" (E. Ebert and E. Meumann: *Ueber einige Grundfragen der Psychologie der Uebungs-Phänomene im Bereiche des Gedächtnisses*, *Arch. f. ges. Psychol.*, 4, 1905, 205). One of the observers reports (p. 20) that reproduction followed "almost automatically" on the basis of auditory after-images. Compare the experiments on the range of consciousness, where forty impressions may be present simultaneously according to Wundt (*op. cit.*, 335), apparently without any sign of "mixture."

<sup>10</sup> N. Ach, *Ueber die Willensthätigkeit u. d. Denken*, 1905, 10. (Italics mine.)

<sup>11</sup> M. Wertheimer, *Experimentelle Untersuchungen zur Tatbestandsdiagnostik*, *Arch. f. d. ges. Psychol.*, 6, 1906, 123. Cf. the *nachklingende Bereitschaft* of Pohlmann, *Exp. Beitr. zur Lehre vom Gedächtnis*, 1906, 28.

"understands by perseveration (*a*) the tendency of a psychical content to remain in consciousness, to continue even in the face of an opposing tendency, and (*b*) the tendency which may be ascribed to a psychical content *b* to return into consciousness, not only because *ab*, but because *b* (*xb*), was once present." Some authors, on the other hand, use perseveration to indicate not both, but only one of these tendencies. Jung and Riklin<sup>12</sup> "use the name 'perseveration' in the sense of the investigations of Müller and Pilzecker," and mean by it "*merely the continuance of the previous idea*, in so far as this continuance is manifest in the character of the following reaction." Ebert and Meumann<sup>13</sup> limit the conception in another way. "Perseveration apparently played a very unimportant rôle with our observers. Four men . . . maintained very definitely that outside of the special experimental hours a spontaneous appearance of the material which we had presented to be learned never occurred." Even within a single one of these meanings, we often find further limitations and extensions. Jung and Riklin,<sup>14</sup> for example, use the term merely as classificatory and descriptive; "it is not meant to be explanatory." In their sense, "the concept has no relation to the perseveration in organic brain-processes," although Müller and Pilzecker had quoted just these cases in support of the perseverative tendency. Nor has it any relation to "the hypothetical 'secondary function of the brain-cells,' which for some authors explains the psychological after-effects of the directive idea"; although Müller and Pilzecker<sup>15</sup> insist that the perseverative tendency has a definite influence in holding the mind to one particular course of thought, or in bringing it back to a previous course after an interruption. Jung and Riklin do not count the recurrences of the same reply at different times during an experiment as perseverations, but have a separate category, repetitions, for these reactions. They give, as instances of perseveration, such cases as *melt*—*hot* followed by *slow*—*fire*, where, as they say, the conditioned reaction is an association to the previous stimulus-word; although Müller and Pilzecker attribute to perseveration alone those cases solely in which association is not concerned. They take account of perseveration only in case the influence is apparent in the very next reaction after that in

<sup>12</sup> C. G. Jung u. F. Riklin, *Diag. Assoziationsstudien*, 1906, 31. (Italics mine.) Cf. E. Stransky: *Ueber Sprachverwirrtheit*, 1905, 28.

<sup>13</sup> *Op. cit.*, 154.

<sup>14</sup> *Op. cit.*, 31 f.

<sup>15</sup> *Op. cit.*, 75. Cf. W. Schäfer, *Ueber die Nachwirkung der Vorstellungen*, 1904.

which the influencing word is found. In general, we find a large number of instances in which the concepts of perseverative tendency and perseveration are changed from their original sense, and made to fit in with the purposes and convenience of the particular author using the terms.

As we have indicated above, the perseverative tendency is sometimes equated to the "impressional tendency," or to that "readiness" of the idea to be reproduced, which is dependent upon the recency, frequency, etc., with which the impression has been made, and which does not depend upon the strength of its associative connections. With such a conception, the perseverative tendency becomes effective for reproduction only when associative tendencies are also brought into play. This view is held, for example, by Wreschner.<sup>16</sup> "Rather must we say that associative tendencies to reproduction are always added to the perseverative. Certainly the former may be of such little strength or so highly complicated that the single elements are unconscious or, if you prefer, only dimly conscious, and so the appearance of freely aroused ideas may be given. . . . But if I understand correctly the developments made by Müller and Pilzecker, they only maintain the fact that the associative factors do not alone determine the course of ideas, but that along with these factors the perseverative tendencies also have to be taken into account, since they are often present in such a high degree that the associative factors, although never entirely lacking, lose their importance." This also is the way in which Watt<sup>17</sup> conceives the perseverative tendency. "Ideas which have recently been in consciousness have for a certain time the property of coming to consciousness again very easily and quickly, or of being reproduced. . . . This property is called the perseverative tendency of the ideas, and we say that such ideas are in a state of readiness." The question whether or not ideas may rise freely into consciousness, Watt regards as in need of experimental test. The close relation of the perseverative tendency to the impressional tendency is pointed out by Titchener.<sup>18</sup> "Why, then, should we separate impressional and perseverative tendency? Why should we not say, at once, that the impressional tendency varies, oscillates, fluctuates?" And the answer given is that the status of the perseverative

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<sup>16</sup> A. Wreschner, *Die Reproduktion und Assoziation von Vorstellungen*, *Zeitsch. f. Psychol.*, Ergbd. 3, 1907, 13 f.

<sup>17</sup> H. J. Watt, *Experimentelle Beiträge zu einer Theorie des Denkens*, *Arch. f. d. ges. Psychol.*, 4, 1905, 341.

<sup>18</sup> E. B. Titchener, *Text-Book of Psychology*, 1910, 400 f.

tendency (as a sort of rhythm imposed on the impressional tendency, making it now and again effective for reproduction) is uncertain, and that the alleged cases of perseveration are explainable in better recognized ways.

Perseveration, moreover, has not been limited to ideas and other content-processes, but has been extended to explain the course of consciousness at large. Witasek<sup>19</sup> speaks of the perseveration of feeling. "After it has just disappeared, an act-feeling of definite character establishes a tendency to be aroused again upon another provocation soon after, even though this provocation under other circumstances would not in and of itself be suitable to arouse just that feeling." Stein<sup>20</sup> and other workers in the psychology of testimony speak of the perseveration of feeling-tone. According to some writers not only do we have a perseveration of mental processes, but also of forms of consciousness and of mental acts. One of the clearest and most definite statements of this position is given in the following quotation from the conclusion of Koffka's<sup>21</sup> article on rhythm. "We must ask what it is that perseveres, the form of the groups, the activity, or both together. From our results it follows with certainty that the forms of the groups as such have perseverative tendencies. Such groups persisted, even when the rhythmic experience had ceased, and mere regularity had taken its place. A perseveration of the activity itself is to be recognized when, after a rhythm is once established, a new rhythm is more easily called forth than it would have been without the previous one." Maltzew<sup>22</sup> finds that observers required to judge the pitch of tones or the interval between tones often report a pitch or interval just previously reported, and calls this a perseveration of the pitch or of the interval. Watt<sup>23</sup> speaks of the perseverative tendency of the *Aufgabe*; Ach<sup>24</sup> discusses the perseveration of a determination, as indicated by the continued correctness of reaction without repetition of directions before every experiment, and by the occasional slip into an old disposition when a new or difficult task is set, and the

<sup>19</sup> S. Witasek, *Grundlinien der Psychologie*, 1908, 341 f.

<sup>20</sup> P. Stein, Tatbestandsdiagnostische Versuche bei Untersuchungsgefangenen, *Zeitsch. f. Psychol.*, 52, 1909, 162. Cf. Jung and Riklin: *op. cit.*, Wertheimer, *loc. cit.*

<sup>21</sup> K. Koffka, Experimental-Untersuchungen zur Lehre von Rhythmus. *Zeitsch. f. Psychol.*, 52, 1909, 108.

<sup>22</sup> C. v. Maltzew, Das Erkennen sukzessiv gegebener musikalischer Intervalle in den äusseren Tonregionen. *Zeitsch. f. Psychol.*, 64, 1913, 224 ff.

<sup>23</sup> *Op. cit.*, 343 f.

<sup>24</sup> *Ueber den Willensakt und das Temperament*, 1910, 55 f.

instructions are not thoroughly ingrained in the observer. In this general and more or less descriptive and classificatory sense, we find a very large number of cases in which recourse is had to the term perseveration. Almost as numerous as the users of the term are the sorts of behavior that are regarded as symptomatic of perseveration; the observer in an association-experiment reacts with a previously given stimulus-word or reaction-word, reacts continuously in the same psychological, logical, or grammatical form (rhyme, similarity, opposition, etc.), reacts with a topical sequence of words, and so on.<sup>25</sup>

The result of our historical survey, then, is as follows. The terms perseveration and perseverative tendency are used almost interchangeably. They may mean that there is a tendency for ideas once impressed to come to consciousness rhythmically or otherwise, with or without the assistance of the associative tendencies; that ideas once in consciousness tend to remain in consciousness for a certain length of time or to run a temporal course; that certain ideas, from the mere fact that they have been more strongly impressed, are readier to appear in consciousness than are ideas less strongly impressed; that feelings, acts, and dispositions may show the same tendency as ideas in one or more of these senses; and that certain types of physical or 'mental' behavior may be expected under given circumstances. The theory of perseveration, we conclude, derives for the most part from incidental psychiatric observation and from the psychological investigation of memory and association.<sup>26</sup> The problem of perseveration has not been attacked by itself or for its own sake.<sup>27</sup>

Many explanations have been offered of the facts alleged to prove the necessity of the assumption of perseveration in

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<sup>25</sup> See Wreschner, *op. cit.*, 11 f., 15, 237 ff.; Jung and Riklin, *op. cit.*; E. Meumann, *Intelligenzprüfungen an Kindern der Volksschule*, *Exp. Pädagogik*, 1, 1905, 96 f.; R. R. Rusk, *Mental Association in Children*, *Brit. Jour. Psychol.*, 3, 1910, 365; T. Ziehen, *Ideenassoziation des Kindes*, *Samml. v. Abhand. aus d. Gebiete der päd. Psychol. u. Physiol.*, 1, Hft. 6, 1898, 25 f.

<sup>26</sup> P. Ephrussi, *Experimentelle Beiträge zur Lehre vom Gedächtnis*, *Zeitsch. f. Psychol.*, 37, 1904, 56 ff., 161 ff.; W. Jacobs, *Ueber das Lernen mit äusserer Lokalisation*, *Zeitsch. f. Psychol.*, 45, 1907, 43 ff., 161 ff. Many others might be added to the list of references.

<sup>27</sup> Heilbronner, Stransky, Schäfer, *opp. cit.*, and Poppelreuter, *Nachweis der Unzweckmässigkeit der gebräuchlichen Assoziations-experimente*, usw. *Zeitsch. f. Psychol.*, 61, 1912, 1 ff., and Ueber die Ordnung der Vorstellungablaufes, *Arch. f. d. ges. Psychol.*, 25, 1912, 209 ff., touch the problem perhaps more directly than others.

the sense of spontaneous appearance, and the question as to whether or not the facts can be explained on the basis of the selective or combined action of such factors as mere persistence of peripheral excitation, unrecognized associations, remote associations, place associations, impression, determination, and the like, seems an open one.<sup>28</sup> We hope that the following experiments may contribute towards an answer to this question.

### III. EXPERIMENTAL

#### *Preliminary experiments.*

In a small number of preliminary experiments an attempt was made to eliminate or to neutralize the effect of associations between nonsense-syllables, while conditions still remained favorable for the induction of strong perseverative tendencies. Under such conditions it was thought that syllables might be spontaneously reproduced, or that they might show their influence in consciousness in some other way. These conditions we tried to secure by the following method.

Five series of six syllables were made up. The syllables were selected by chance from the list in Whipple's *Manual of Mental and Physical Tests* (p. 247); but for the same series no syllable was chosen which, combined with another syllable of the series, would make a sensible word; and no syllable was taken which corresponded with a syllable already chosen in respect to an initial or final consonant. The syllables actually employed were: *dro, zig, luh, ild, tud, pum, aum, rin, orp, ool, sef, nuc, lom, zet, ruj, elt, smi, nen, gla, lel, gur, baw, ime, acq, orm, tob, pru, gos, ith, tas*. The syllables of a series were then written down in the order:

1 2 3 4 5 6 | 3 5 2 6 4 1 | 5 4 6 1 3 2 | 4 2 5 3 1 6 | 2 1 4 3 6 5

In such an order no syllable follows any other given syllable more than once; and no syllable appears to have any special advantage, due to position in the series, over any other.

Four observers took part in the experiments: Miss L. M. Day (D), a graduate student in psychology with four years of psychological training; Mr. A. S. Edwards (E), fellow in psychology; Dr. L. R. Geissler (G), instructor in psychology; and Dr. E. Jacobson (Ja), honorary fellow in psychology.

On a single day, one only of the above described series was read aloud to the observer with an attempt not to introduce rhythm. The writer served as experimenter in this and in all the following experiments. The rate of reading was regulated

<sup>28</sup> See Jesinghaus: *loc. cit.*; Titchener: *loc. cit.*; Wundt: *loc. cit.*; H. Ebbinghaus: *Grundsüge der Psychologie*, 1902, 657 f.

by a noiseless pendulum set to beat three-quarter seconds, and a syllable was given at each beat with the skip of a single beat between each group of six syllables. The observers were instructed to give equal and best possible attention to all syllables; but they were told that they would not be required to recall the syllables afterward. During the reading the observer, with closed eyes, sat at the end of a couch upon which, as soon as the reading was finished, he lay down. During the following interval of one minute he was instructed not to think of the syllables, but to be as passive as possible and to think of going to sleep, or to attend passively to sensations from the skin and body, if such attention should seem necessary in order to keep his attention from the syllables. At the end of the interval the observer had the task of giving slowly, at a suggested rate of approximately one per second, a list of nonsense-syllables of any character, "just such as came into his head."<sup>29</sup> The experimenter recorded for thirty seconds the syllables given, and took an introspective report of the whole experience in so far as the observer was able to give it.

It would seem, theoretically, as if such a method should by the arrangement of the series eliminate definite associations, to a great extent at least, through both associative and reproductive inhibition; while by the factors of strong attention, repetition, recency, small demand upon the attention of the observer in other directions at the time when the list of syllables was being said, and perhaps also by the shortness of the series, the perseverative tendency should still be favored.<sup>30</sup>

The following table shows (1) the number of syllables out of the thirty given in the lists by the various observers, (2) the number of times which such syllables appeared as repetitions, (3) the number of syllables which corresponded to syllables in the series in respect to two letters only, (4) the sums of these numbers (totals of "influenced" syllables), (5) the number of other syllables, and (6) the total number of syllables in the lists.

A study of the Table shows that for all observers except Ja the number of "uninfluenced" syllables is much larger than that of "influenced" syllables. In spite of the fact that the perseverative tendency has been favored by the factors

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<sup>29</sup> Compare the method used by W. Peters, Ueber Ähnlichkeitsassoziation, *Zeitsch. f. Psychol.*, 56, 1910, 167.

<sup>30</sup> Müller and Pilzecker speak (p. 58) of the perseveration not only of an idea but also of a series of ideas, and state (p. 64) that the perseverative tendency of the syllables of a series is still of some strength after five minutes.

which we have mentioned, all syllables cannot be 'perseverations.' Perhaps the instruction to give a *list* of syllables prejudiced our observers against repetition of syllables. As has been shown by other investigators, learning without the intent to remember, and reproduction without the instruction to give right syllables only, usually result in a small number of "right cases,"<sup>31</sup> though we have little evidence to show whether, under these conditions, associative, perseverative, or "impressional" tendencies are weak.

TABLE I

	D	E	G	Ja
(1) Stimulus syllables given . . . . .	11	10	8	14
(2) Repetitions of stimulus syllables . . . . .	9	13	5	15
(3) Part repetitions . . . . .	29	23	21	31
(4) Total "influenced" list-syllables . . . . .	49	46	34	60
(5) "Uninfluenced" syllables . . . . .	93	113	94	58
(6) Total syllables in list . . . . .	142	159	128	118

A large number of rhymes appear in the lists, and it is due to these in large measure that the numbers of part repetitions [see Table I, line (3)] largely exceed the numbers of stimulus-syllables and repetitions of stimulus-syllables [see lines (1) and (2)].

The observers report that it was not difficult to keep the syllables from coming to mind during the interval. When syllables did come, a probable basis for association was usually given.

D says: "The sounds were absolutely dismissed from mind by moving on the couch. They did not recur. During the rest-period I thought of sleep and said to myself 'Go to sleep.' I tried to keep my eyes fixed toward the window and not turn them towards the experimenter. Once I did turn my eyes involuntarily toward the experimenter and had an indistinct thought of the series, but no definite syllables." "When I lay down, a thought of the syllables came up. (Eyes turned toward the experimenter, vague visual image of the

<sup>31</sup> See, e. g., Poppelreuter, *Zeitsch. f. Psychol.*, 61, 1912, 1 ff.; A. Aall, Ein neues Gedächtnisgesetz?, *Zeitsch. f. Psychol.*, 66, 1913, 1 ff.

experimenter and table, and kinesthetic feel of the beat of the series.) I looked around and moved eyes before any syllables came."

E says: "Felt pressure of eyelids on eyeball (I often use this as a means of getting to sleep), thought of time passing, and thought the time seemed long. No clear ideas, and no syllable came up even indefinitely. Attention on feel of hands on chest, feet hanging over end of couch, etc."

G reports: "Not always a blank as required, because the period was too long. At first attention on drowsy sensations, sort of swimming in head, pressure sensations from face on pillow, noticed ticking of clock, hiss of steam, then a few verbal ideas to which I attended, told myself not to think of words. This brought back two or three syllables in verbal form, *sef* and *dag*. Then another blank—forgotten its contents."

Ja reports: "Persistently increased tonicity of the muscles of the face, twitching of the muscles in the left arm, memory of conversation about a dream which I carried on with G a few minutes ago. Turned my eyes toward experimenter, visual image of him, and then the syllables *zin*, *lom*. Then I noticed that I was introspecting, clock and steam catch attention, then attention on kinaesthetic sensations in arm and legs."

Introspections of the period during which the list is given show that very frequently the observer voluntarily or involuntarily "thinks of the series," and that syllables belonging to the series are thereby brought into consciousness. Rhyming seems to be dependent, in part at least, upon a partial persistence of the previous syllable. The greater number of "influenced" syllables in the case of Ja may be explained by his report that it is easiest to give a list by sometimes thinking of the series.

D reports: "Consciousness of the *Aufgabe*, setting of my throat, eyes turned toward the experimenter, vague, visual recollection of the series (table and experimenter); looked around and moved eyes, scowled, kinaesthetic verbal image of *l*, started to say it and the rest of the word came of itself; auditory-kinaesthetic images of two or three syllables; said to myself, 'you are making them all from one letter'; remembered that I could do so, but must not do so consciously. Let throat take care of itself unless I felt stuck, then visual image of experimenter and table, *s* came up, and rest of syllable came up of itself; other syllables seemed to follow automatically." "Voluntarily set my throat and it keeps setting itself the same way."

E says: "While I was giving one syllable, the next one often came up auditorily; wondered whether I should think of the syllables read or make an effort not to. They did not seem to come up of themselves, except one—*lom*." "Kinaesthetic set which meant the problem, i. e., to give nonsense-syllables; kinaesthesia in throat when searching for consonants; consonant *l* came up auditorily, and started to speak at the same time; a second syllable came up auditorily as I began to say the first. Sometimes several consonants seemed to be there at once, and one gains its place by the vocal organs following the line of least resistance. The vowels come simply as an automatic filling-in; very often do not get the vowel auditorily until after I have said it. Noticed when I gave *bil* that the *l* was clear in consciousness and began the next syllable."

G says: "Some syllables seem to come of their own accord after a consciousness in which attention is on the sensations from the articulatory organs. Others are suggested by the sound of the previous ones, that is, certain vowels or consonants—chiefly consonants—seem to repeat themselves because the organs are still set for their reproduction. Search for a syllable generally means a kinaesthetic memory-image of the previous vowel, and anticipatory kinaesthetic image of one or two other vowels. The initiatory consonant seems to take care of itself. Sometimes an image of the last consonant of the previous syllable."

Ja. "As soon as E said, 'Say the list,' verbal motor setting and start to speak. Syllables seem to say themselves. I said *blu* and then *plu*, which suggested that I was voluntarily trying to give the series read over again. Then I attempted to let the syllables come of themselves in a greater degree. After a little no syllables formed themselves naturally, and I came back to a thought of the series. This seems to be the easiest way to give a list."

A close scrutiny of the "uninfluenced" syllables shows that a great many of them are very similar. Certain letters are repeated over and over again. Table II will serve to indicate the number of times in which the more frequent initial and final consonants appear in the "uninfluenced" syllables with the different observers. In the case of Ja vowels are given five times as initial and six times as final letters. So great a frequency of particular letters and so great an agreement among observers as to the most frequent initial and final letters can not be the result of chance. Neither is explanation possible on the supposition that certain letters in the series which was read were more frequent or attracted attention more definitely; for the most frequent initial and final letters given by the observers in the "uninfluenced" syllables are not especially frequent as initial and final letters in the series read; and as matter which will be presented later shows, greater attention-compelling power of certain letters is not such as to explain the preponderance.

Certain letters, especially *l*, *m*, and *n*, are likely to appear as initial letters; and others, such as *l*, *m*, *n*, *r*, and *s* are likely to appear as final letters, when one decides to say something without knowing what one is going to say. Further account of this phenomenon will be given in our discussion of the results obtained in later experiments (p. 420).

The main conclusion to be drawn from these preliminary experiments is that, under conditions such as ours, where the perseverative tendency is intentionally favored, and the associative tendencies are neutralized, there appears little or no evidence of spontaneous reproduction. The apparent influence of the syllables read may be explained in terms of association, impression, determination, and continuance.

TABLE II

Obs.	Total Cases	Initial Letters				
		l	m	p	s	r
D	93	24	15	12	8	7
E	113	l 20	z 15	d 14	r 10	k 7
G	94	l 14	m 13	g 12	f 10	s 10
Ja	58	n 9	l 8	t 5	p, z, w 4	
Final Letters						
D	93	l 26	m 25	p 18	n 7	t 5
E	113	k 25	g 16	m 15	b 9	d 7
G	94	n 28	r 17	m 12	f 9	s 8
Ja	58	b, k, m, p 5				

Variations of the experiments, in which parallel series in the same (not in a mixed) order were learned along with such series for comparison, will be described later (p. 421).

*Experiments by the Method of Right Associates.*

According to Müller and Pilzecker, the influence of the perseverative tendency is especially evident in the results of the method of right associates.<sup>32</sup> We determined therefore to perform certain experiments by this method. We began with two observers, the D and E of the preliminary experiments, neither of whom had previously worked with this method or was especially well acquainted with the literature in this field. Experiments were made on three alternate days *per* week, and always at the same hour of the morning.

The nonsense-syllables used were adapted from the list 1-60 of Müller and Schumann's twelve-syllable normal series, pub-

<sup>32</sup> *Op. cit.*, 281.

lished by Rupp in 1909. Certain changes were made in these syllables, in order that they should be easier for our observers to pronounce; *sch* was changed to *sh*, *ü* to *au*, and so on, and syllables which had meaning in English were modified. Subsequent series were made up by the experimenter in accordance with Müller and Schumann's rules. The syllables were type-written and presented step-wise by means of the Spindler and Hoyer memory apparatus.<sup>33</sup> As usual, two blank spaces were left at the end of the series. After preliminary practice, the speed of rotation of the drum was held constant at 8.2 secs. The accented syllables were exposed in the test in the space to the right of the place of presentation. Reaction-times were measured by the Hipp chronoscope, connected in make-to-break series with the exposure apparatus and a Cattell lip-key. The chronoscope was situated in a distant room, and the readings were taken by a second experimenter. Before each experimental hour the chronoscope was tested by means of the large Wundt control-hammer, set at 150 $\sigma$ , and adjustments were made to reduce the mean variation of the reading to 1.5 $\sigma$  or less. The absolute time of the chronoscope reading was found by the use of Wundt's chronograph.<sup>34</sup> That the chronoscope-times may be regarded for practical purposes as absolute is shown by the fact that ten trials with the Wundt hammer gave  $150 \pm 1.3 \sigma$  as measured by the chronoscope, and  $149 \pm 1.2 \sigma$  as measured by the chronograph; with a different setting of the control hammer,  $180.2 \pm 1.3 \sigma$  with the chronoscope, and  $179 \pm 0.5 \sigma$  with the chronograph. Sixteen tests with a large control-pendulum gave with the chronoscope  $1758.4 \pm 1.5 \sigma$ , and with the chronograph  $1757 \pm 1.6 \sigma$ . These figures show that the chronoscope, adjusted for constancy at 150 $\sigma$ , was also reliable for the much longer times which frequently occurred in our experiments.

In the first experiments, much as in the earlier experiments of Müller and Pilzecker,<sup>35</sup> the observers were instructed to read the series in trochaic rhythm, giving equal and best possible attention to all syllables, not to think of the syllables during the interval between learning and test, to react in the test as quickly as possible, trying to give the unaccented syllable immediately following the stimulus-syllable in the learning series, but not waiting for absolute conviction of the correctness of a syllable which came to mind without such

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<sup>33</sup> Catalogue 21, 1908, No. 215.

<sup>34</sup> *Op cit.*, III, 383 ff.

<sup>35</sup> *Op. cit.*, 8 ff.

conviction, and to respond with the word "Nothing" if no syllable came. After the test, which on the average took less than a minute, the observer was required to write as complete an introspection of the course of the experiment as he could. With this requirement it was found possible to complete in an hour two experiments, with a five-minute rest between them.

Table III shows the quantitative results obtained from 12 series by each of the two observers. The interval between learning and test was three minutes and the number of repetitions was eight. The values were computed as by Müller and Pilzecker (pp. 26 f).

TABLE III

Obs.	*r	Tr	f	Tf	v	Tv
D.....	.39	3,290	.42	4,790	.10	16,970
E.....	.09	1,480	.83	1,190	.07	1,490

\*r = percentage of correct replies; f = percentage of incorrect replies; v = percentage of cases in which no reply was given. Tr, Tf, Tv, are the rounded averages of the reaction times of the correct, incorrect, and no replies, respectively. The percentage of cases in which the reply corresponded to the correct reply in respect to at least two parts out of the three (beginning consonants, vowel or diphthong, end-consonants) may be obtained by 1.00-r-f-v.

The striking difference between the results of the two observers is at once apparent. E gives many less correct replies and many more incorrect replies than D, and his times throughout are very much shorter. Although, as we shall see from the results of later experiments, E's command of a series in learning and his retention and reproduction of it are probably in general considerably less than D's, this fact alone is not sufficient to explain the differences in the above results. The difference is rather due, primarily, to the fact that E evidently laid the greatest stress on that part of the instructions<sup>36</sup> which requires a reaction *as quickly as possible*, and permits reactions *of whose correctness the observer is not certain*. While both the percentages of cases and the times of the right and incorrect responses in the results of D correspond very closely with the values given by Müller and Pilzecker's observer Jahn under the same conditions (.39 to .39,

<sup>36</sup> Before the work of every hour the instructions were always read to the observer, or read by him from a slip pasted in the note book in which introspections were written.

3290 to 2230, .42 to .38, 4790 to 3200, .10 to .18), E's times fall far below the times both of D and of Jahn. In the early experiments, when judging the correctness of his responses, E would sometimes report: "The syllable is all right, but I and doubtful about its position," meaning that he recognized the syllable as a member of the learned series, but that he could not tell whether or not it was the syllable which had immediately followed the stimulus-syllable. E's attention was specifically called to the fact that no such syllable could properly be called correct or "all right," but no appreciable effect on the number of subsequent right cases appeared. E merely changed the form of his report on correctness. E rarely reported that a syllable came to mind and was rejected; he usually thought about the correctness of a response only after the response had been given.

In learning, E's attention was chiefly on the pronunciation of the syllables, and he paid "much less attention to the way the syllables looked or sounded." He had little difficulty in not thinking of the series during the interval after learning until the experimenter said "Get ready." Then, after E had adjusted the lip-key, he began to "get ready to reply." The following is a characteristic account of this period. "Strong strain sensations. Fixation of the screen. Vague and fleeting visual images,—indistinguishable dark forms on a white ground—a tendency to form the vocal organs." Sometimes during this period images of actual syllables appeared, usually in auditory or auditory-kinaesthetic form. With the experimenter's "Ready," strains increase. The stimulus-syllable is nearly always reported as having been read visually without internal speech. After the perception of the stimulus-syllables, various processes are reported. In a very few cases recognition of the stimulus-syllable occurs, or some other reference is made to the place of the syllable in the learning series. Sometimes a "blank" or a "mass of strain sensations in the head" is reported. Most frequently, however, the perception of the stimulus is at once followed by a "taggy" image of the reply-syllable or of a part of it. These taggy images are about equally often visual and auditory-kinaesthetic. When these images come, E at once starts to speak, developing the syllable "vocally" if only part of it is given in image. Almost as frequently E reports that a syllable or part of a syllable "forms itself mechanically upon the tongue" and "says itself," or the syllable "shoots off automatically." Very often this mechanical reproduction is followed by visual or other imagery of the spoken syllable, which helps the observer to spell what he has spoken and to decide whether the syllable is a true member of the series or not. Sometimes, in the period between successive stimulus-syllables in the same test, E gets ready for the next reaction as he does for the first reaction, and reports images of the learned series or of parts of it; but usually the getting ready consists merely in fixation of the screen and increased strain in the eye-muscles and in the throat and chest.

D very frequently finds the nonsense syllables meaningful, especially in the first few series. Certain syllables were felt to be like "some-German word," *heil-gaam* suggested a proper name, *zus-shaun*

seemed like *süss-schön*, and so on. Certain syllables were more pleasant than others.

D, like E, finds that most attention needs to be given to the pronunciation of the syllables, but unlike E she finds that, after two or three repetitions, she can pay attention to the "looks" of the syllables, can "run over" them visually, sometimes fixating certain letters in turn, and can very frequently anticipate the coming syllable in visual or kinaesthetic imagery. D has considerable difficulty in preventing herself from thinking of the series during the interval, and says she must "keep talking or else think about the experiment." The thought of the series, when it does arise, is reported sometimes as "a visual image of a white strip over there," sometimes as "a white strip on the drum," sometimes as merely "a tendency to turn the eyes towards the exposure-slit." Sometimes in these cases specific syllables appear, in auditory-kinaesthetic or in kinaesthetic imagery. When getting ready for the test, D reports a consciousness of the *Aufgabe*, represented in a number of ways, at different times. Most frequently at first appear verbal images, such as "quickly" and "get that syllable," often with "taggy visual images" of the strip or of a part of the strip on which the syllables are written. Sometimes these taggy images are all that is reported. Sometimes no visual images appear, but D reports "kinaesthesia of eye-movement to the left," or a "kinaesthetic attitude, which means 'get the syllables.'" Quite often, with these representations of the *Aufgabe*, D has auditory or auditory-kinaesthetic (rarely visual) images of specific syllables. Strain sensations and fixation of the screen seem to be less prominent with D than with E.

D generally reads the stimulus-word in internal speech, and sometimes repeats the word once or oftener. Immediately after this D practically always realizes or attempts to realize the place which the stimulus had in the learning series. This realization is characteristically in terms of actual or imagined eye-movement, with or without vague visual images of syllables or dark spots on a white background to the left. "Impulse to turn eyes to the left and down," "hurried eye-movement," "a quick dart of the eyes toward the upper part of the series" are introspections of this period. After this kinaesthetic or kinaesthetic and visual localization, in a large number of cases "taggy" images of the reply-syllable appear in visual or auditory-kinaesthetic form, and the reaction is immediately made. Sometimes, however, as in the case of E, D reports that "the reaction-word said itself as a muscular continuation of reading the stimulus," and sometimes that "there was effort to get something to say (throat-movements)." Sometimes, when no imagery or imagery of only a part of the reply-syllable appears, D replies "by starting to say something and trusting the throat to finish it."

E's reactions, then, if we may be permitted to make the comparison, seem to approach the abbreviated or muscular type; D's the natural or central type. In order to get a more complete and accurate description of all periods of the learning and of the reproduction consciousness, and especially of the processes concerned in the reproduction of the incorrect replies, we determined to favor quick reproduction by definite instructions, to increase the number of our observers, and to

carry out a number of purely qualitative experiments before and after the experiments of the main quantitative group. The conditions in this series of experiments were identical with those just reported, save that the four new observers were tested after an interval of one minute instead of after three minutes, and save that here all observers were told to place the chief emphasis upon reacting *as quickly as possible*. They were still to try to give the right associate, but were told not to discard any syllable which came to mind, unless that syllable were felt to be incorrect before a reply could be made. Besides the two original observers, D and E, there took part in this work Dr. H. P. Weld (W), assistant professor of psychology; Mr. C. A. Ruckmich (R), instructor in psychology; Mr. R. C. Holl (H.), and Mr. J. S. Johnston (J), graduate students in psychology. W and J had had previous experience in experiments on memory. Twelve series were given to each observer. The results of the experiments are shown in Table IV.

TABLE IV  
3 MINUTE INTERVAL

Obs.	r	Tf	f	Tf	v	Tv
D.....	.22	1,360	.58	1,630	.11	2,430
E.....	.07	1,390	.70	700	.11	1,490
1 MINUTE INTERVAL						
W.....	.21	810	.52	1,430	.21	2,440
R.....	.29	750	.56	1,050	.03	2,570
H.....	.25	680	.39	1,020	.27	3,470
J.....	.06	590	.64	780	.29	3,150

After this group of experiments, the instructions were again changed. The other conditions remained the same, for both groups of observers, as in the previous experiments. The observers were, however, now instructed to take as much time for finding the correct unaccented syllable as seemed to them likely to make for correctness, and not to reply with the first syllable which came to mind unless they felt that it *might* at least be correct. Table V gives the results of twelve series with each of the observers.

TABLE V  
3 MINUTE INTERVAL

Obs.	r	Tr	f	Tf	v	Tv
D.....	.43	4,610	.42	6,600	.01	9,052
E.....	.25	2,970	.58	11,410	.08	19,000
1 MINUTE INTERVAL						
W.....	.29	3,200	.41	6,840	.12	14,780
R.....	.24	1,130	.50	1,540	.03	4,560
H.....	.47	3,330	.39	4,770	.04	8,470
J.....	.19	5,610	.60	7,860	.14	18,880

As might perhaps be expected from the fact that he reacted very rapidly in the experiments whose results are given in Table III, E's results in Table IV do not differ greatly from his results in that table. The number of right associates remains approximately the same. There is a slight decrease in the number of incorrect replies, with a corresponding increase in the number of partly right syllables, due perhaps partly to practice in learning. All the reaction-times are somewhat shortened, but Tf still remains less than Tr. With D, however, the change is considerable. Her correct replies are fewer, her incorrect replies are more, and her reaction-times are much shortened. W, R, and H (Table IV) show great similarity of results in the experiments under the instruction to put the emphasis on rapidity of reaction, both with regard to percentages of right and wrong cases, and in the length of reaction-times. These reaction-times are much shorter than those of D, who gives approximately the same *r*-percentage under the same instruction, but who is tested after a longer interval.<sup>87</sup> J, who had considerable difficulty in reading the syllables at the rate of speed at which they were presented, falls far below the other observers of his group in respect to the number of correct replies.

With the instruction to put the emphasis on correctness rather than on speed all of the observers except R, for whom there is a small decrease (more than compensated by the greater number of partly right responses), give more correct replies than with the second instruction, and all save H, who

<sup>87</sup> Cf. Müller and Pilzecker, *op. cit.*, 47 ff.

gives an equal number, give fewer incorrect replies. The reaction times without exception show an increase in length.

Before and after the groups of experiments whose results are shown in Tables IV and V, we carried out a number of experiments identical with those of the main groups except for the fact that the experiment was interrupted at a point in its course known beforehand to the observer, e. g., after the learning, or after the first or a following reaction; and an introspection of the period immediately before the interruption was required. On the basis of these introspections, as checked by the introspections given in the main groups, the following attempt is made to characterize the conscious processes of our observers during these periods.

In the learning period, with the instruction to react as quickly as possible, D reports less attention to the visual aspect of the syllables than with the first instruction, and more attention to pronouncing them correctly and emphatically. "Tried to keep my throat set for the first syllable of a pair until the second was in the field, making the accompanying kinaesthesia for the pair continuous. There was, too, something in the eye-kinaesthesia that made the two syllables of a pair group together and separate more definitely from the next pair." "Tried deliberately at first to keep attention on each syllable while it remained in the field, but found that after a few repetitions my throat tended to continue with the second syllable of the pair while the first was still in the field. There was also incipient eye-movement upward toward the coming syllable, and occasionally a hazy anticipatory visual image. . . . Before the last presentation the second syllables of all the pairs but one were correctly anticipated." The syllables less frequently have meaning than before. E's introspections correspond very closely with his introspections for the first group of experiments.

For W learning was "almost entirely a vocal-motor affair." The syllables were "read off" with clear enunciation and strong accentuation. W, like D, also "goes from the final consonant of the first to the beginning of the next syllable of a pair without a break in speech" and tends to "make the syllables (of a pair) like one word." Meanings for the syllables are infrequent and W tries to "inhibit" them.

R pays little attention to the visual side of the experience, but the kinaesthetic and auditory sides are very clear. He reads the series as a whole into one rhythm, accenting most strongly the first and ninth members. His voice drops slowly till the sixth syllable, and then rises till the eleventh, with a drop at the end. The whole series forms "a unitary kinaesthetic-auditory complex." He anticipates the second syllables of the pairs after a few repetitions kinaesthetically, later auditorily also. The series differ greatly for R in their pleasantness or unpleasantness, depending, he maintains, upon all three factors of ease of pronunciation, sounds of the individual syllables and of combinations of syllables, and visual appearance of certain syllables.

H pays attention chiefly to the pronunciation and to the visual appearance of the syllables; after the first few repetitions, more especially to the latter. He anticipates the syllables, for the most part

in visual, but sometimes in other terms. The syllables very frequently have sensible meaning for him.

J, as we have before noted, has trouble in reading the series as fast as it is presented, and in the first or second presentations occasionally falls behind and has to skip a syllable or a foot. After the third repetition, however, he begins to pay attention to the looks of the syllables.

Learning under the third instruction differs little from learning under the second, save in the fact that attention for most observers, but especially for D, E, W, and H, is now more than before upon the visual side of the experience.

In the interval between learning and test, D and E report slightly fewer cases in which a thought of the series occurs, than in the first series of experiments. Of all our observers W has the greatest trouble in keeping his mind off the syllables. He made a practice of rising from his chair and walking about the room singing or whistling until called back for the test. R had little trouble after the first few experiments, and J never reported the appearance of a syllable during the interval in any experiment. H reported syllables in about as many cases as did D.

The preparation of D and E for the test in the later experiments is very like that in the first group of experiments. D reports more and stronger strain sensations for the second instruction than for the third, and notes especially the strains in chest and throat, and stronger fixation of the screen. Reference to the learning series often appears, both in the visual and kinaesthetic forms before described and as a general kinaesthetic set, and with this reference syllables sometimes come up in imagery, especially in auditory-kinaesthetic terms. Sometimes the getting ready is reported by E merely as a total bodily set, strain sensations especially in face, chest and throat, strong fixation of the screen.

Visual images of the white strip of paper, and auditory-kinaesthetic images of specific syllables are very frequent with W during the period of getting ready for the test.

R frequently has auditory-kinaesthetic imagery of the series in this period. Thus he reports "a hazy group of auditory imagery which seemed to be a jumble of a number of the nonsense-syllables with no definite order or rhythm. Then some of the syllables were imaged (auditory-motor) together in a series, but I can't now tell which ones." "A number of syllable combinations started to come and seemed to crowd together in the focus of attention."

H usually waits passively for the stimulus to appear in the experiments both of the second and of the third instruction. Sometimes he reports "a visual field with syllables in it as vague, darker lines," but usually he reports that "there is just an empty visual field."

J first "gets set muscularly for a quick reply." Then before him there is a sort of "dark, hazy, slightly transparent background" in which at times certain syllables of the series appear as darker forms to the right of the slot in the apparatus.

E finds no difference in conscious content between reproduction under the second and under the first instruction. D less frequently reports repetition of the stimulus-syllable in internal speech; but practically always, when the reply does not follow as a "muscular continuation of the stimulus," D reports actual or imagined eye-movements to localize the stimulus in the visual scheme which represents

the learning series. Very frequently there is a visual or auditory image of the reply-syllable preceding or accompanying utterance.

W most frequently reports that the reply was "purely vocal-motor, without anticipatory imagery." "The reply comes immediately to my throat, or tongue, and is followed by visual imagery of the syllable said." R either reacts in vocal-motor fashion after visual or visual and auditory-kinaesthetic perception of the stimulus, or the reaction is preceded by an image—usually kinaesthetic or auditory-kinaesthetic—of the syllable or of a part of it. H also responds "automatically" sometimes, but for the most part, he reports that the syllable is present in hazy visual imagery before the reply is given. J always reports that the reply-syllable, as a darker form in the visual background, appears before a reply can be made. Under the third instruction the reproduction-consciousness seems much the same as with the previous instruction in the cases of W, R, and J, save that the strain sensations of the preparatory period are less intense and that the processes in the reproduction-period run their course more slowly. For D and H the visual imagery is clearer and more definite, and the reply-syllables are hardly ever given "automatically." Frequently the first syllable which comes is discarded, and a search (either imagined eye-movement or visual imagery) takes place.

When, as in our experiments, a recently learned series is tested by the method of right associates, a large number of the incorrect replies are found to be identical with the syllables of the learning series. Other replies correspond with syllables of the learning series in respect to two letters. Table VI shows the percentages of syllables of the first kind under the rubric *frr* (false row-right); the percentages of syllables of the second kind under the rubric *frp* (*p*=part). The totals of *frr*+*frp* are shown in the fourth column, and the percentage of the false cases which are either *frr* or *frp* is shown in the fifth column.

By far the greater part of the incorrect replies—on the average about three-fourths of them—are actual or partial reproductions of syllables of the learning series. The small percentage in the case of R under the second instruction is due to the fact that sometimes his reply in this group of experiments was a syllable which, added to the stimulus syllable, made a sensible word.

Especially with the purpose of investigating the relations of the incorrect responses, in their dependence upon the interval between learning and reproduction, a group of experiments was undertaken with two observers, W, and Miss J. N. Curtis (C), scholar in psychology, who had had a good deal of previous practice in experiments on memory. Two sets of experiments of twelve series each, the one with four repetitions of the series and a test after one minute, and the other with twenty-four repetitions and a test after twenty-four hours, were made with C as observer. A set of series

TABLE VI

Instr.	Obs.	frr	frrp	Total	$\frac{\text{frr} + \text{frrp}}{f}$
					f
Group I.....	D	.29	.10	.39	.93
	E	.20	.30	.50	.60
Group II.....	D	.22	.35	.57	.98
	E	.21	.19	.40	.57
	W	.33	.08	.41	.79
	R	.03	.10	.13	.23
	H	.31	.04	.35	.89
	J	.39	.13	.52	.81
Group III...	D	.19	.19	.38	.90
	E	.29	.25	.54	.93
	W	.10	.22	.32	.78
	R	.09	.24	.33	.66
	H	.32	.04	.36	.92
	J	.24	.14	.38	.63

identical with the latter was made with W, who was given one test and afterwards learned one series on each experimental day. C did the same, with the addition of learning and reproducing a series with the shorter intervals between the test of one twenty-four-hour series and the learning of the next. The instructions and the other conditions of learning were the same as in our second group of experiments by the method of right associates, where the emphasis was placed upon reacting as quickly as possible. The reaction-times were recorded in twenty-fifths of seconds, written by a time-marker connected with the Kronecker interrupter, and are expressed in Table VII in tenths of a second.

TABLE VII

	r	Tr	f	Tf	v	Tv
W 24 hours.....	.02	9.0	.73	14.3	.16	25.8
C 24 hours.....	.23	5.7	.30	8.4	.26	11.2
C 1 minute.....	.49	1.6	.22	5.2	.17	7.9

C explained that, on account of past experience in memory experiments, where "ingenious" learning was encouraged, she found it almost impossible to learn nonsense-syllables without attaching sensible meanings to them. She found the attempt to repress such means of memorizing so disturbing that it did not seem advisable to instruct her to do so. To her mode of learning is to be attributed the high percentage of right cases, shown in her results both for the shorter and longer intervals. She reported that most of the syllables of any series had meaning for her in learning, and that these meanings often linked sensibly the accented to the unaccented syllables of a pair. In tests after the one-minute interval, however, these sensible meanings often played no conscious part for C. In general, she reports, first, "an auditory-kinaesthetic image of the stimulus syllable as it sounded in my own voice." Then, if a kinaesthetic or auditory-kinaesthetic image of the reply-syllable does not appear quickly and easily, C "tries to think of the meaning." If still no image of the second syllable appears, the stimulus-syllable is repeated in internal speech a number of times.

In tests after twenty-four hours, C usually reports a perception of the stimulus-syllable as a verbal meaning; then follow various sorts of imagery; usually, however, predominantly visual. An auditory-kinaesthetic image of a reply-syllable usually appears, but is frequently modified in expression, though not in meaning, before it is given.

W learns "in vocal-motor fashion." In the test he repeats the stimulus-syllable over and over, sometimes a reply-syllable is spoken "as if a continuation of speaking the stimulus-syllable," but usually after considerable repetition W decides "to say something" without knowing what he is about to say. He rarely reports during the test a reference to the learning series.

Both observers report cases in which syllables appear outside the experimental hour; but both maintain that in all cases the syllable appears in connection with a thought of the experiment or of the laboratory, usually represented visually.

In our second group of experiments by the method of right associates, when the test took place after a one-minute interval, and where eight repetitions of the series were given, 63% of the incorrect replies given by W were nevertheless syllables of the series. In the tests after twenty-four hours, with twenty-four repetitions, only 4% of his incorrect replies were members of the series. In tests after one minute with four repetitions, 28% of C's incorrect reactions were syllables belonging to the series, while in tests after twenty-four hours with twenty-four repetitions, 20% of these reactions were members of the series.

As we have seen in our historical discussion (p. 396) Müller and Pilzecker consider the fact that in general, in tests of recently learned series, a greater number of the incorrect syllables are identical with syllables of the learning series than in tests of series after longer intervals, as an indication of the greater strength of the perseverative tendencies in the first case. If, instead of perseverative tendencies, we read readi-

ness of the syllables for reproduction, or strength of their impression, the explanation seems as adequate. Certainly when strong secondary associations are present, as in tests which follow soon after learning, the free appearance of syllables cannot be supposed. And if, as is usually maintained,<sup>38</sup> the secondary associations lose in strength relatively more rapidly with time, then it is to be expected that the direct associations will be those more effective after some time has elapsed, and that frr cases will be the exception.

We have found numerous cases in which a particular syllable is given as a reply several times in the same test and in the tests on different days; but the explanation can, at least in many cases, be made without supposition of free arousal. D, for instance, gave *maan* as an incorrect reply in experiment 3 with the report: "Visual perception of the stimulus; eye-movement to place it in the series, but no syllable came; eye-movements continue over place of series, then suddenly visual image of *maan* (the spelling of *maan* had made a distinct impression on me in learning). Said it at once." This is an instance of an frr syllable aroused through a place association. In experiment 9 D gives the correct reply *maun* with the report: "The stimulus-word *hos* made a strong impression on me (in learning) as the first syllable of a person's name, and the second syllable as meaning *man* was connected with it; pleasant organic sensations. Now with perception of *hos* and recognition of its place in the series, in terms of eye-movement and visual image of the exposure field, the same organics as before. Set my throat, a lot of eye-movement; then *maun* came out in a great hurry." In the experiments under instruction to react quickly, 13-24, *maan* appears twice as an incorrect reply, *maal* three times, *man* once and *mmm* . . ., an uncompleted reply, once. In every case D reports that after the stimulus-syllable nothing would come; then occurred a hurried eye-movement over the place of the series and a setting of the throat, which finally is released by utterance. In one case a visual and in one case an auditory-kinaesthetic image of the syllable is reported as preceding utterance. Not until experiment 24 did D realize that a similar syllable had previously been given as a reply. D, then, especially when no syllable will come visually, sets her throat to say something. With this setting of the throat the saying of a syllable beginning with *m* has become strongly associated, and is now realized in the absence of other associations. W gives as incorrect replies, under the instruction

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<sup>38</sup> Ebbinghaus, *op. cit.*, p. 647.

to reply quickly, *neuf* twice, *neb* twice, *nez* once, *nef* once, *nev* once, *nif* once, and other syllables beginning with *n* and *m* once each. Under the third instruction he gives *mal* three times, *ner* twice, *nur* twice, *neuf* twice, and other syllables such as *nar*, *nal*, once each. In practically all such cases W reports strain in the throat, hesitation, or a blank, "I am stuck" feeling. In the incorrect replies of the other observers similar syllables are given when the observers are at a loss for the reply and "set their throats to say something."

It is noteworthy that all the five *habituelle Aushülfesilben* *nöf*, *laf*, *noch*, *mön* and *meun*, listed by Müller and Pilzecker (p. 62), begin with *l*, *m*, or *n*, the letters which we found to occur so frequently as initial letters in our experiments by the method of right associates, and in the "uninfluenced" reactions in the preliminary experiment. With the method of right associates in 207 reactions, in which the incorrect response did not correspond even in respect to two letters with the syllable of the series, the frequency of the initial letter was: *n*, 48; *m*, 35; *l*, 22; *t*, 19; *r*, 13. The frequency of the final letters was: *m*, 28; *l*, 26; *r*, 26; *f*, 18; *s*, 14. By chance, each letter should occur about ten times. If we arrange the total number of letters, substituted for the correct letters in the reactions where a syllable is given which corresponds with a syllable in the series in respect to two letters, we find the following relations of frequency. For 183 initial letters: *n*, 32; *t*, 28; *m*, 25; *l*, 20; *d*, 20. For 171 final letters: *r*, 31; *l*, 28; *s*, 27; *m*, 22; *f*, 20. By chance, each letter would occur here about nine times. Observers seem to differ very little from one another in respect to the letter most frequently given in these cases, but the smallness of the number of cases prevents us from drawing more definite conclusions. Certain experiments without the lip-key and other experiments, in which the Rousselot microphone was used, show that the form of key or the absence of any key makes no appreciable difference in the character of the response, so far as the predominance of these letters is concerned. These same initial and final letters appear frequently in the totally wrong cases in tests of series of syllables in which the letters themselves do not appear, and even with observers unaccustomed to work with nonsense syllables. It does not seem, then, as if these *habituelle Aushülfesilben* were necessarily recurrences of syllables recently attended to.<sup>39</sup>

<sup>39</sup> The letters, which, from their frequency in the right cases, appear to have an especial attraction for attention, are not by any means in our experiments the same letters as those appearing most frequently in the *Aushülfesilben*. Cf. Müller and Pilzecker, *op. cit.*, pp. 254 ff.

*Experiments by the Method of Retained Members.*

A series of experiments by the method of retained members in which the method somewhat resembled that of our preliminary experiments, was also performed.

With the exceptions mentioned below all conditions of experimentation were the same as in the experiments by the method of right associates. On each day a twelve-syllable series of nonsense-syllables was presented for eight repetitions and read by the observer precisely as in the method of right associates (repeated series). After an interval of one minute the observer gave as many of the syllables as he could recall in 45 seconds, reacting with the lip-key. Alternately before and after this series a second twelve-syllable series was presented and tested. In the successive presentations of this second series (mixed series), as in our preliminary experiments, the order of the syllables was so changed that no single syllable was ever in the eight presentations followed by the same syllable as in any previous presentation. The syllables were so arranged also that no syllable had any special advantage over any other by reason of its position (first or last in the presentation) or by reason of accentuation (first or last in a pair), and two different arrangements were used still further to decrease the chances of advantage of syllables by place in the series. By this arrangement strong direct associations should be avoided. The syllables of this second form were typewritten on a long strip of kymograph paper, the eight arrangements following one another with the customary two blank spaces between presentations. The actual exposure was made by the Spindler and Hoyer apparatus, the strip being rolled as a band over a second light drum at the back of the apparatus. The times of the reactions were recorded graphically on a Ludwig-Baltzar kymograph, and the actual times recorded alongside of these in twenty-fifths of a second by a marker connected with the Kronecker interrupter. After preliminary practice the observers found little difficulty in using the lip-key for successive reactions, though in a few cases the observer believed that the second reaction may have been slightly delayed by the necessity of closing the key after the first reaction. After a short preliminary practice, 12 experiments with each sort of syllable order were made with all of the four observers W, R, H, and J. The observers were told to give not only such syllables as they were sure belonged to the learning series, but also other syllables which occurred to them, if they believed that these other syllables might possibly be correct.

TABLE VIII

Obs.	Total Reactions		Right Reactions		Incorrect Reactions	
	Rep.*	Mix.†	Rep.*	Mix.†	Rep.*	Mix.†
W	79	74	.51	.55	.18	.27
R	103	95	.46	.60	.32	.21
H	88	81	.83	.77	.05	.09
J	66	66	.59	.52	.06	.17

\* Rep.= Repeated order.

† Mix.= Mixed order.

As is evident at once from the above Table the percentage of correct replies after an interval of one minute is not directly dependent upon the fact that the direct associations are repeated and strengthened in learning, for the percentage of right reactions is nearly as great (H, J), or even greater (W, R.), when no such repetition occurs, as is the case in the mixed order. The rather surprising fact that W and R give slightly more correct syllables and that H and J give almost as many correct syllables in the series with the mixed order, as in the other series where the direct associations are repeated eight times, is undoubtedly to be explained by strong indirect associations and by strong impression. Three of the observers report that the individual syllables in the mixed order stand out more clearly in attention. In the mixed order the observers do not know, when one syllable is in the field, what the next syllable will be, as they very often do in the repeated order. The consequence of this unpreparedness is that the observer's attention to the presented syllable is always demanded in a high degree. All observers report that more attention has to be paid to the visual appearance of the syllables in the mixed order. That direct associations are not of primary importance for recall of a very recently learned series is also shown by the fact that the usual order of recall of syllables with the repeated order of presentation is not the order of the syllables in the learning series. The first syllable to be recalled is two-thirds as often the eleventh of the learning series as the first, and the other syllables follow in very irregular order. Still another fact that tends to show the same thing is that out of 48 cases in which a correct syllable is followed by a correct syllable in the reproduction of the series with repeated order, R gives the directly associated syllable only 11 times; W gives it in only

10 cases out of 49; H in only 21 cases out of 70; and J in 9 cases out of 48. The number of times in which the following syllable in these cases is the syllable immediately preceding the given syllable in learning for R is 9, for W is 4, for H is 11, and for J is 6.

The average length of time elapsing after the experimenter's "Now" and before the observer's first, second, third reaction and so on, is given in the following Table. No averages are calculated for those places in which less than six reactions appeared, and the times which were measured in twenty-fifths are here expressed by the nearest tenth of a second.

TABLE IX  
OBSERVER W

Place	1	2	3	4	5	6	7	8	9
Time: rep.....	3.9	6.8	8.0	9.9	15.9	22.0	31.3	35.4	....
Time: mix.....	2.4	5.4	7.9	11.9	22.2	28.9	34.3	....	....

OBSERVER R

Place	1	2	3	4	5	6	7	8	9	10
Time: rep.....	1.3	2.2	3.7	6.3	9.7	17.1	23.3	24.3	32.6	34.4
Time: mix.....	1.2	2.6	4.6	6.9	12.1	17.4	26.1	34.7	39.8	....

OBSERVER H

Place	1	2	3	4	5	6	7	8	9
Time: rep.....	1.9	4.1	7.4	11.2	17.1	18.2	20.1	26.7	29.6
Time: mix.....	1.7	3.9	5.8	9.4	18.1	23.9	27.4	28.6	....

OBSERVER J

Place	1	2	3	4	5	6	7	8	9
Time: rep.....	2.9	5.3	7.9	9.2	10.6	14.2	26.5	....	....
Time: mix.....	2.1	3.5	5.9	9.5	12.8	20.3	31.3	....	....

In the recall of the series with repeated order, the observers give the first or first few reactions later on the average, and

the following reactions sooner on the average, than in the series with mixed order. The difference is especially great in the case of W, and can at least in his case be explained on the basis of his introspections. "With the short [*i. e.*, the rep. order] series it takes time to readjust, to put myself into the set of the learning series. I start to *visualize* the series." "At 'now' very brief time in which I readjusted. Blank; visual field dark, visual image of syllables." "This reproduction is very different from the reproduction in the long [*i. e.*, mixed order] series. There I was waiting for a release; here there is a real recall." In general, then, in the repeated series W tries to get back into the learning situation and to visualize the syllables. In the mixed series, however, the first syllables follow in vocal-motor fashion a set of the throat. After the first three or four syllables, usually comes a time during which no syllables are given. W reports: "Relief, passivity, attention on nothing in particular." Then W tries to get the syllables visually or repeats over in internal speech the syllables already spoken. A similar state of affairs is also reported by H. R reports that reproduction follows the "now" in auditory-kinaesthetic terms in both cases; reproduction for J is usually in visual terms. The shorter time of the first replies in the mixed series may depend upon *vocal-motor* readiness, due to higher attention. The increased time in the later replies is explained by the fact that the direct and the place associations in this form of series are weak. In the repeated series place and direct associations continuously aid the observers.

The incorrect replies of this method are distributed almost entirely in the last part of the recall-period. A large number of them are very similar, and resemble the *habituelle Aushülfesilben* of the method of right associates. With W, for instance, *nev* is given as an incorrect reply five times before the series of experiments is two-thirds finished, and not until that time does he realize that it has been given before. When the fact is noticed, he remarks: "I think this syllable has come up a number of times before. I don't think it is in to-day's series at all. It came when I was balked; I felt helpless, my throat was tense, I was waiting for something to come, and my face and eyes were screwed up. Feeling of emptiness. Determined to say something and *nev* was uttered. Then I saw it in type, not black, but reddish." After this report the syllable did not appear again in the series. R and J also report that such syllables are uttered after the throat is set in an attempt to say something.

## IV. CONCLUSION

In the historical section of this paper, we pointed out that the concept of perseveration has acquired a wide variety of meanings. Perseveration may be the designation of at least four psychologically distinguishable states of affairs. (1) It may mean that a content-process has a tendency to run a temporal course, to have a *continued* existence. Since this meaning is implied in the very term "process," it seems useless to adopt a special term for designating it. (2) Perseveration may mean that a content-process, having once appeared in consciousness, does not at once disappear from consciousness, but stays or remains *in* consciousness for a certain time without reference to a change in its durative character.<sup>40</sup> (3) Perseveration may mean that a given mental formation which has once been in consciousness is likely to appear in consciousness again. (4) Perseveration may mean that, if a given mental formation has once been in consciousness, its recurrence need not be attributed to any condition save this of having once been in consciousness.

It is the factual justification for this latter concept that our experimental work has called into question. In our experiments we have met no facts which seem to make necessary the supposition of a tendency for an idea to arise without the probable coöperation of associative tendencies. When a syllable-idea came to the mind of our observers, in the interval between the learning and testing of series, or in the intervals outside of the experimental hour, the observers reported that such an idea followed or accompanied an idea of a larger situation of which it formed a part. In the "natural" rhyming of syllables, which occurs when the problem of relatively unrestricted speaking of a list of nonsense-syllable is given, our observers find cases in which the previous sound is still in consciousness when the new syllable arises. We have maintained that the syllables which are habitually given as reactions by observers, in the method of right associates, when the observer is at a loss for vocal-motor expression, are in many cases not syllables which have been previously learned, but are rather natural reactions, due merely to the intention to utter *some* nonsense syllable; and we believe that the recurrence of such replies may be sometimes partly explained by an association of the given motor impulses to the conscious processes characteristic of the state. The greater number of false cases in the tests of recently learned syllables is expli-

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<sup>40</sup> Jesinghaus, *op. cit.*, 366.

ble, we believe, by the assumption that indirect or remote associations lose relatively much more rapidly in strength than do direct associations, and that, as more and more repetitions are given to a series, the repetitions become more and more effective for the direct and less and less effective for the indirect associations within the series, through the partial inhibition of the latter by the former. In a series, therefore, in which direct associations are equal to those in another more recently learned series through the advantage of more frequent repetition, the remote associations will be much weaker, and in it the number of false cases which are syllables of the series will be less.

The shorter reaction-times of right syllables in recently learned series, whose percentage of right cases is equal to that of another less recently learned series, may be explained as readily on the basis of strong impressional tendencies or greater readiness of the syllables, as by postulating perseverative tendencies.

The non-experimental observations which have been urged in support of the theory of a free arousal of ideas or feelings and the continuance or recurrence of a given form of mental activity, may be explained, on the basis of some or all of the following factors; unnoticed motives to association, such, for instance, as kinaesthetic or organic sensations; strong impression or determination; remote associations; place associations, and the like. Many alleged instances of perseveration may be explained as the mere continuance of the given process instead of its re-arousal.

Finally, conditions which are supposed to favor perseveration do not always bring about a reproduction. We may have been *recently* awakened from a *vivid* dream, and we may *try* in vain to remember the ideas of the state, whereas an idea associated to a dream idea will often accidentally bring up that idea without our endeavor to remember. The stimulus associated to an action in the patient's mind by the operator in hypnosis may touch off the suggested but forgotten action at a later time, even though the action be foolish.

Not only may the necessity of supposing a spontaneous recurrence of mental contents be questioned, but a spontaneous activity in the nervous system, which seems thereby to be implied, is also made improbable by physiological facts so far known.<sup>41</sup>

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<sup>41</sup> See Wundt, *op. cit.*, 572 f.; Jesinghaus, *loc. cit.*; Poppelreuter, *Arch. f. d. ges. Psych.*, 25, 1912, 293 ff.; Titchener, *loc. cit.*